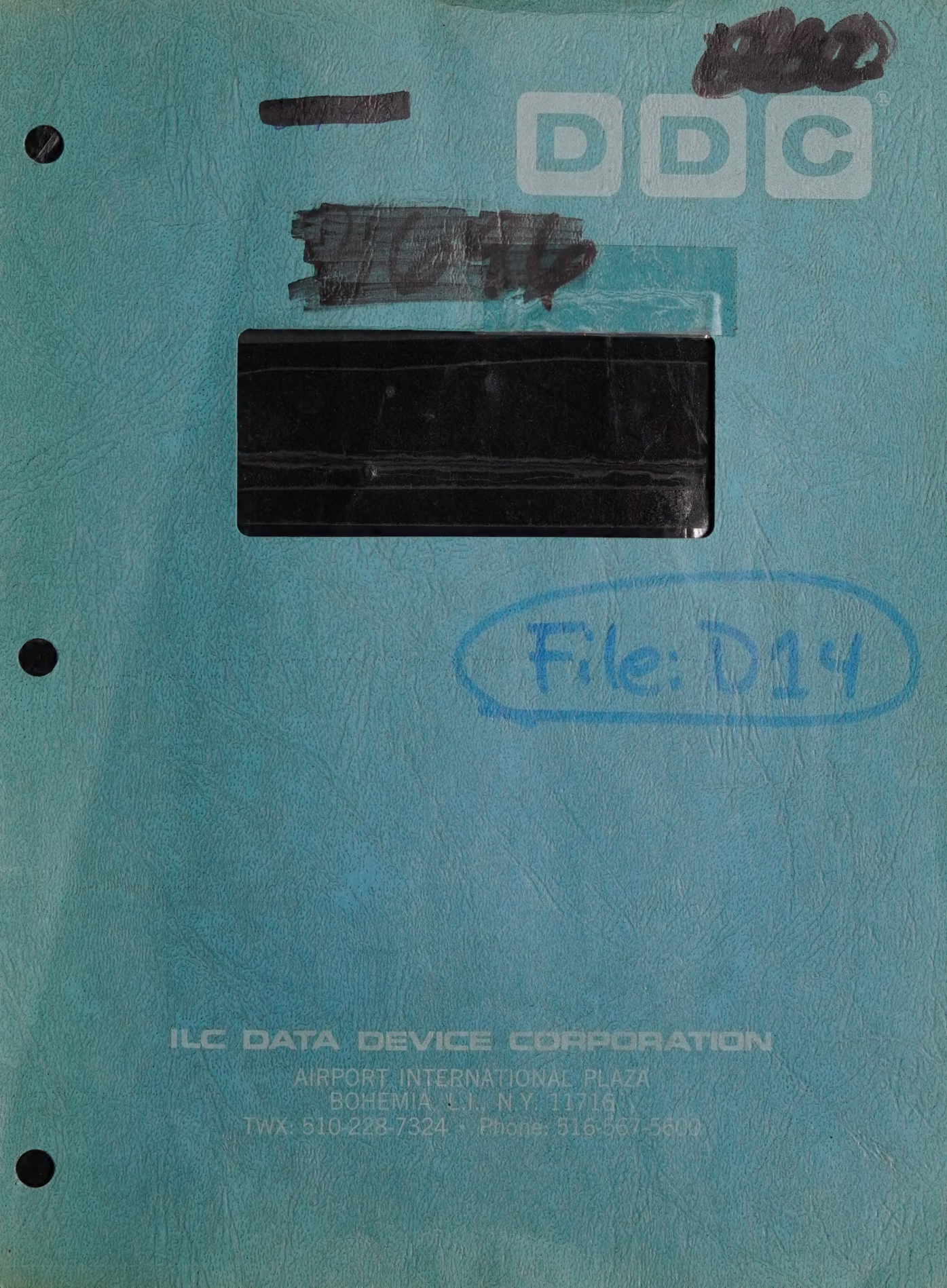

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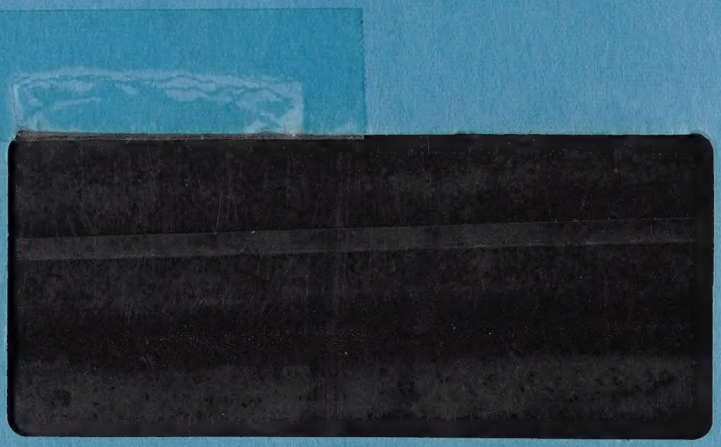

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IM/SR-102A
/HSR-102A
/SR-202
/HSR-202

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INSTRUCTION MANUAL

FOR

SYNCHRO/RESOLVER ANGLE INDICATORS

MODELS SR-102A, HSR-102A, SR-202

AND HSR-202

ILC Data Device Corporation
New York

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A. Model SR-102A

B. Model SR-202

Figure 1-1. Synchro/Resolver Angle Indicators

SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION

This manual contains installation, operation, and maintenance instructions for the Models SR-102A and SR-202 Synchro/Resolver Angle Indicators, manufactured by ILC Data Device Corporation. (See figure 1-1.) The data in this manual and all references to the Models SR-102A and SR-202 are equally valid for the high accuracy versions (Models HSR-102A and HSR-202, respectively) except where noted. The "H" models differ from their basic counterparts only in "accuracy, worst case, all causes" which is ±.01° as compared with ±.03° for the basic models.

1-2. PURPOSE OF EQUIPMENT

The Models SR-102A and SR-202 are precision analog-to-digital converters which continuously digitize and display synchro or resolver angular data in real time with a typical accuracy of ±0.01°.* The Model SR-102A is configured as a remotely programmed unit while the SR-202 provides the additional capability of front panel input and control. Developed from the most advanced analog-to-digital concepts, these dependable solid-state instruments are ideally suited for any application requiring determination of synchro or resolver shaft positions. Utilizing DTL- and TTL-compatible logic, these angle indicators can be easily interfaced with external digital control equipment for such applications as information translators in quality control inspection systems, production testing of synchros and resolvers, aircraft navigation systems, machine tool control, and antenna positioning.

1-3. EQUIPMENT SUPPLIED

Each instrument is supplied with an ac linecord and an interface connector. All remotely programmed commands and output signals are routed through this connector which is wired by the user into the external circuits. Connector pin assignments are given in Section II, Installation and Operation.

*Guaranteed maximum error for Models HSR-102A and HSR-202.

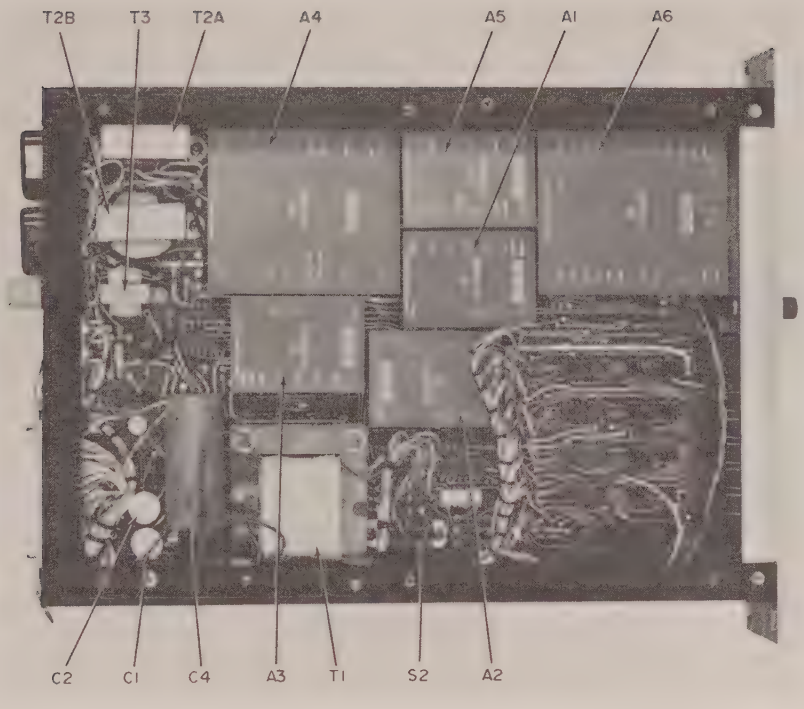
1-4. PHYSICAL DESCRIPTION

The Models SR-102A and SR-202 are small lightweight units designed for either lab bench use or half-rack mounting. Each unit is also available center-mounted in a 19-inch panel or for full 19-inch rack mounting of two units. A combination handle/tilt stand is provided with the SR-202 to facilitate bench operation, and for half-rack or full 19-inch rack mounting of two units, hardware adapter kits are available. The kit permits the SR-202 to be easily mounted in a system or general test equipment rack. The SR-202 can also be combined mechanically with its sister unit, the Model SR-400 Angle Simulator, to make up a single 19" rack mounted unit 3-1/2" high in a configuration that provides a complete synchro/resolver measurement and stimuli capability for Automatic Test Equipment (ATE) Systems.

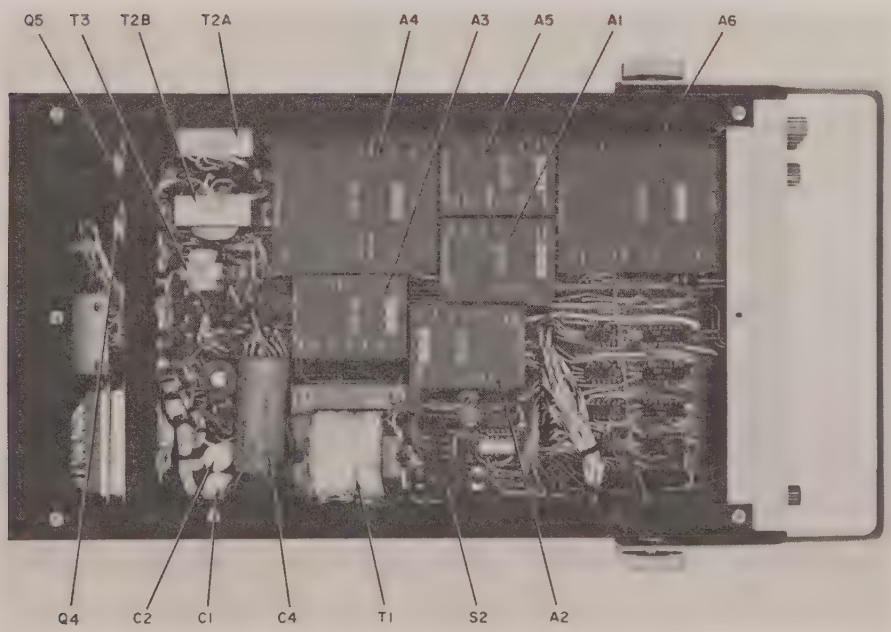
As shown in figure 1-1, the Models SR-102A and SR-202 are equipped with identical 5-digit light emitting diode (LED) displays of shaft angle. A polaroid filter on each LED display ensures good readability even in bright sunlight. A POWER switch adjacent to each display controls the power input to the instrument.

Six pushbutton switch groups and eight binding posts are incorporated on the front panel of the SR-202 to facilitate local operation. The LOCAL-REMOTE switch selects local or remote programming. When the LOCAL pushbutton is depressed, the TRACK-FREEZE, L-L VOLTAGE, BANDWIDTH, and MODE switches are enabled, permitting local control. In addition, the synchro/resolver and reference inputs may be applied to the front panel binding posts. With the REMOTE pushbutton depressed, the remaining pushbutton groups are disabled and programming control is transferred to the external system via the rear-mounted connector. During remote operation, all front panel signal inputs are isolated from the converter.

Removal of the top cover makes most of the subassemblies of each unit accessible. (See figure 1-2.) The analog-to-digital circuits are packaged in six compact encapsulated modules mounted to a common printed circuit (mother) board. The five 7-segment LED's occupy the front left portion of each unit. Power supply components are mounted at the rear of the units. A line voltage selector switch (115/230v) located at the bottom of the mother board, is accessible when the bottom cover is removed. The rear panel of each unit, shown in figure 1-3, contains a multi-pin Amphenol connector, a fuseholder, and the connector for the ac linecord. Two power transistors are also located on the SR-102A rear panel.

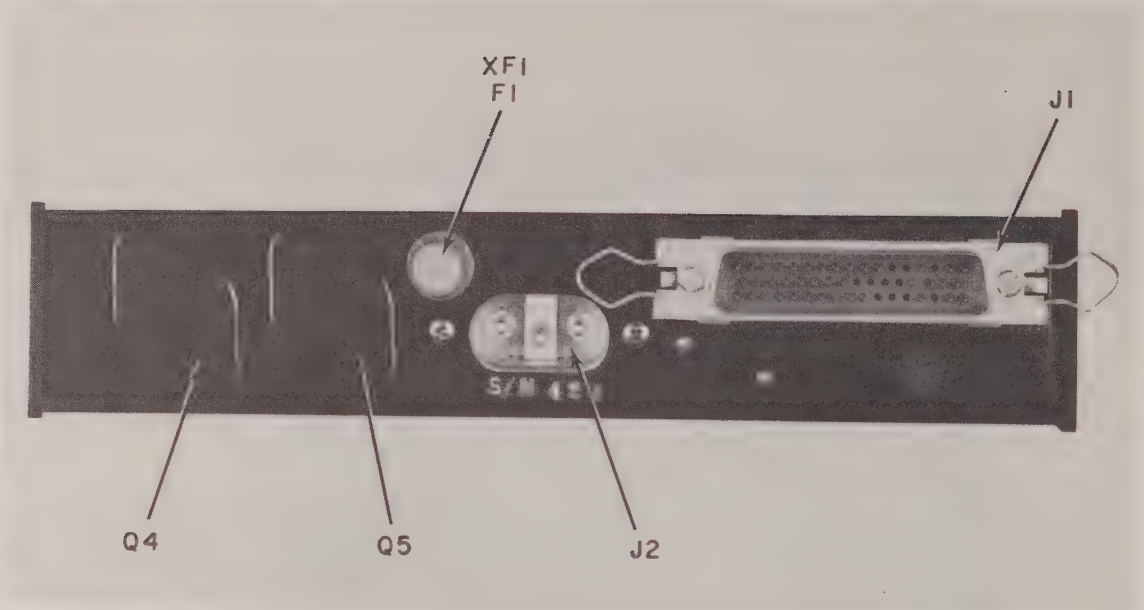


A. Model SR-102A

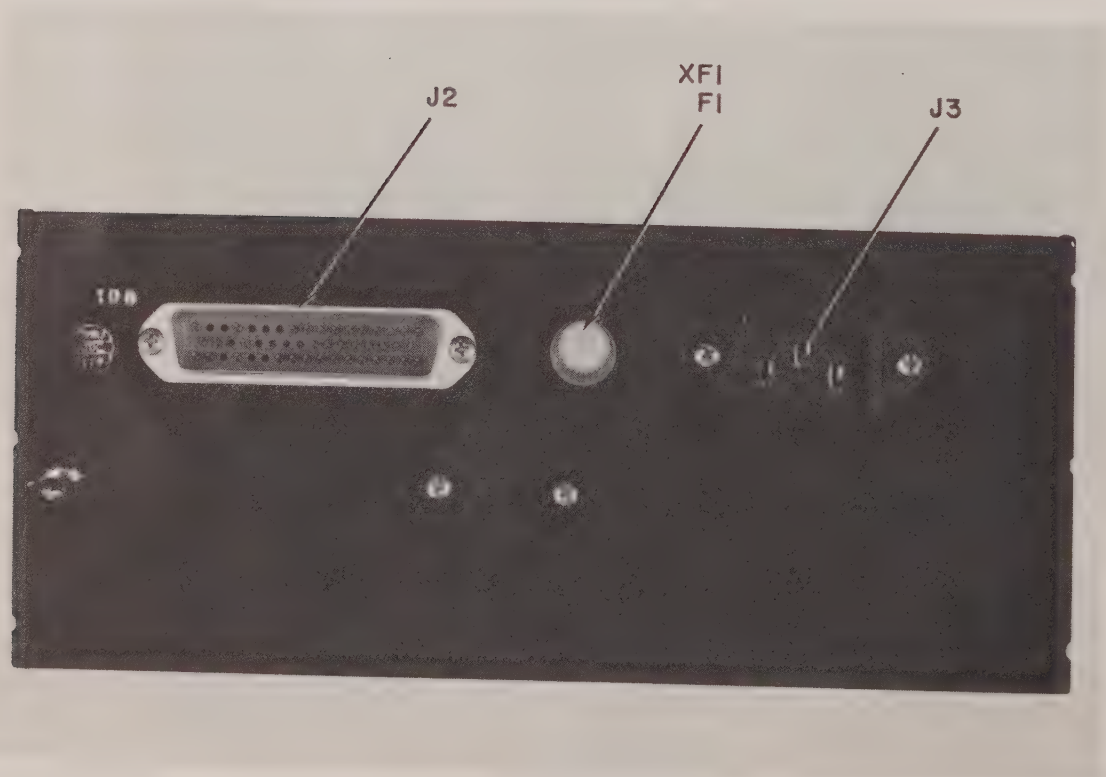


B. Model SR-202

Figure 1-2. Top Views (Covers Removed)



A. Model SR-102A



B. Model SR-202

Figure 1-3. Rear Views

1-5. TECHNICAL CHARACTERISTICS

Table 1-1 summarizes the principal characteristics of the two instruments.

Table 1-1. Technical Characteristics

Angular Range	000.00° to 359.99°, continuous rotation
Accuracy (SR-102A and SR-202)	
Typical	±0.01°
Worst case, all causes	±0.03°
103A .00550	
Accuracy (HSR-102A and HSR-202)	
Worst case, all causes	±0.01°
Dynamics	
Tracking rate, no lag error	1080°/sec at 400 Hz; 250°/sec at 50-60 Hz Signal Input
Synchronizing time (180° Step Input)	0.3 sec
Display	
Type	5 digits, 7 segment, solid state LED's
Resolution	0.01°
Reference Input	
Voltage	10-130 volts rms
Frequency	47 to 1000 Hz, from same source as synchro excitation.
Phase, relative to signal	±20° (for full accuracy)
Input impedance	25 kΩ min.
Isolation	Transformer (500 volts off ground)
Breakdown, to logic gnd	±500v dc
Signal Input	
Type	Synchro or resolver
Voltage, L-L	11.8V/26V/90V
Frequency	Same as reference
Impedance	>2.5 megohms L-L
Tolerances	
Voltage	±20%
Harmonics	±10%
Isolation	Transformer (500 volts off ground)
Breakdown, to logic gnd	±500v dc
Digital Programming Inputs	
Inhibit in	Logic 1 or open = track Logic 0 or gnd = hold (freeze)

Table 1-1. Technical Characteristics (cont'd)

Data enable	Logic 1 or open = θ (input angle) Logic 0 or gnd = 000.00°
Lamp test	Logic 1 or open = θ (input angle) Logic 0 or gnd = 888.88° (all segments on)
Level control No. 1	Logic 1 or open = 11.8v/90v L-L Logic 0 or gnd = 26v L-L
Level control No. 2	Logic 1 or open = 11.8v/26v L-L Logic 0 or gnd = 90v L-L
Bandwidth control	Logic 1 or open = 400 Hz - 1 kHz Logic 0 or gnd = 47 - 400 Hz
Synchro/resolver mode select (Model 202 only)	Logic 1 or open = resolver Logic 0 or gnd = synchro
Digital Outputs	
Shaft angle (θ)	5 buffered BCD DTL decades (18 lines total), positive true logic continuously available, .01° resolution
BITE	Logic 1 = fault Logic 0 = no fault
Converter Busy	Logic 0 = busy Logic 1 = data stable
Power Input	
Voltage	115/230 volts rms ± 10%*
Power	40 va max
Frequency	47-440 Hz
Fuse (rear panel)	Buss, GMW-1, 1 amp
Isolation	Transformer
Temperature Range	
Operating, standard	0° to +50° C
Operating, optional	-55° to +85° C
Storage	-65° to +125° C
Dimensions	
SR-102A	9-1/2" W x 1-3/4" H x 12-5/8" D
SR-202	8-1/8" W x 3-1/2" H x 14-1/2" D
Weight	Under 10 lbs

*Voltage selectable by internal switch. See page 2-1.

SECTION II

INSTALLATION AND OPERATION

2-1. PREPARATION FOR USE

The Models SR-102A and SR-202 are electrically operational in all respects as shipped from the factory. Carefully remove the instrument from the packaging material and inspect the front and rear panels for damage to any parts. A label shipped with each unit should indicate whether the unit is set for 115 or 230-volt operation. If in doubt, remove the bottom cover and check the setting of line voltage selector switch S2. If necessary, use a small screwdriver to set this slide switch for the proper line voltage. Should the instrument show any signs of damage, notify the nearest ILC Data Device Corporation field representative immediately.

2-2. INSTALLATION

No special installation procedures are required if the instrument is to be used on the bench. To mount the SR-102A in a half-rack (mounting holes spaced approximately 8-3/4 inches apart), carefully insert unit into rack and bolt in place with standard hardware. For the SR-202, remove the tilt-handle assembly and attach half-rack mounting ears (factory available). Other hardware is also available for full rack mounting of two units.

2-3. CONNECTIONS

The interface connector supplied with each instrument must be wired to the external system. Table 2-1 lists the connector pin assignments. Solder or crimp each input and output lead to the pins as listed, then push the pins in until they lock in place.

IMPORTANT

These instruments are equipped with separate chassis and digital grounds. For best results, chassis ground (pin 4) and digital ground (pin 9) should be connected together in the external system. When the digital outputs are not used, connect the two grounds together at the instrument.

Table 2-1. Connector Pin Assignments

PIN	FUNCTION	PIN	FUNCTION
1	*	20	Spare
2	*	21	AC Ref Low Input
3	Spare	22	Spare
4	Chassis Ground	23	Spare
5	Spare	24	Spare
6	Spare	25	Spare
7	Spare	26	Lamp Test: "1" or open = θ "0" or Gnd = All 8's
8	Bandwidth (BW) Control: "1" or open = Hi BW (400 Hz - 1 kHz) "0" or Gnd = Lo BW (47-400 Hz)	27	B.I.T.E. Output: "1" = Fault "0" = No Fault
		28	.02° BCD Out
9	Digital Gnd Out	29	.1° BCD Out
10	Inhibit In: "1" or open = Track "0" or Gnd = Hold (Freeze)	30	.8° BCD Out
		31	4° BCD Out
11	**	32	20° BCD Out
12	.04° BCD Out	33	100° BCD Out
13	.2° BCD Out	34	Synchro or Resolver S1 Input
14	1° BCD Out	35	Synchro or Resolver S3 Input
15	8° BCD Out	36	Spare
16	40° BCD Out	37	AC Ref High Input
17	200° BCD Out	38	Spare
18	Synchro or Resolver S2 Input	39	Spare
19	Resolver S4 Input	40	**

Table 2-1. Connector Pin Assignments (Cont'd)

PIN	FUNCTION	PIN	FUNCTION
41	Input Level Control No. 1 "1" or open = 11.8V/90V L-L "0" or Gnd = 26V L-L	45	.01° BCD Out
		46	.08° BCD Out
42	Input Level Control No. 2 "1" or open = 11.8V/26V L-L "0" or Gnd = 90V L-L	47	.4° BCD Out
		48	2° BCD Out
43	Data Enable: "1" or open = θ (input angle) "0" or Gnd = 000.00°	49	10° BCD Out
44	Converter Busy: "1" = Data Stable "0" = Busy (4 μsec duration)	50	80° BCD Out

*SR-102A:

When using instrument to measure synchro angle, connect pin 1 to pin 2. When using instrument to measure resolver angle, be sure pin 1 is NOT connected to pin 2.

SR-202:

Pin 1 is synchro/resolver select
"1" or open = Resolver
"0" or Gnd = Synchro

Pin 2 is digital ground

**When using display blanking feature, connect pin 11 to pin 40. (See para. 3-3.)

2-4. OPERATING PROCEDURE (MODEL SR-102A)

Attach the wired interface connector to the mating connector on the rear of the instrument. Connect the line cord between the unit and the appropriate power source (115 volts or 230 volts, as applicable). Program the appropriate input lines (identified in table 2-1) for the desired synchro or resolver format, line-to-line voltage, and either low or high bandwidth. Depress the POWER switch to apply power. No other procedures are required. The digital readout should display the synchro or resolver shaft angle represented by the applied input voltages.

NOTE

If no digital readout appears on the display, but the decimal point and degree sign light (provided the automatic BITE blanking feature is wired), recheck the input connections. If trouble persists, refer to Section IV, Maintenance.

2-5. OPERATING CONTROLS AND INDICATORS (MODEL SR-202)

The controls and indicators used in the operation of the Model SR-202 are shown in figure 1-1 and described in table 2-2.

2-6. OPERATING PROCEDURE (MODEL SR-202)

a. Remote Operation. Remote operation of the Model SR-202 is identical to that described for the SR-102A. Refer to paragraph 2-4.

b. Local Operation

1. Connect the synchro/resolver and reference inputs to the appropriate front panel binding posts.

2. Depress the LOCAL pushbutton.

3. Depress the SYN or RSLVR pushbutton to operate the unit from synchro or resolver inputs, respectively.

4. Depress the L-L VOLTAGE pushbutton that corresponds to the voltage level of the applied synchro or resolver voltages.

5. If 47-400 Hz signal frequencies are to be used, depress the LO BANDWIDTH pushbutton. For signal frequencies of 400 Hz or higher, depress the HI BANDWIDTH pushbutton.

NOTE

If the digital and chassis grounds have not been tied together at the rear connector, be sure to interconnect the two at the front panel binding posts.

6. Depress the POWER pushbutton.

Table 2-2. Model SR-202 Operating Controls and Indicators

Item	Function
DEGREES display	A 5-digit LED display that indicates decimal value of synchro/resolver input angle with a resolution of .01°.
POWER switch	When depressed, applies ac power to unit.
TRACK-FREEZE pushbuttons	When TRACK pushbutton is depressed, digital output of unit tracks the analog input angle within the specified accuracy. Depressing the FREEZE pushbutton causes the digital angle to freeze at last setting regardless of subsequent changes in angular input. NOTE If the unit is wired for automatic BITE blanking, and the angular input continues to change, the display will eventually blank.
BANDWIDTH pushbutton	When HI pushbutton is depressed, unit is conditioned to track at higher tracking speeds and acceleration constants (for signal frequencies of 400 Hz or higher). When LO pushbutton is depressed, unit is conditioned for low bandwidth operation (47 through 400 Hz).
LOCAL-REMOTE pushbuttons	When LOCAL pushbutton is depressed, front panel controls program operation, front panel binding posts accept synchro/resolver and reference inputs, and programmed input commands from external system are disabled. Depressing the REMOTE pushbutton transfers all control functions (except POWER on-off) to external system inputs, disables front panel control functions, and isolates front panel signal and reference inputs.
L-L VOLTAGE pushbuttons	Depressing the 11.8V, 26V, or 90V pushbutton conditions the unit for operation with the corresponding input voltage levels. (Unit is protected against damage in the presence of signals up to 115 volts rms if 11.8 or 26 volts is programmed.)
MODE pushbuttons	Depressing the SYN or RSLVR pushbutton conditions the unit for operation with synchro or resolver type inputs, respectively.
LAMP TEST momentary action pushbutton	Depressing the LAMP TEST pushbutton causes all LED segments to light, producing test display (888.88°).

SECTION III

PRINCIPLES OF OPERATION

3-1. INTRODUCTION

Functionally, the Models SR-102A and SR-202 are identical except for the additional manual control capabilities incorporated in the latter. For this reason, only the SR-202 is described in detail. Overall schematic diagrams of the two units appear in Section IV.

Standard DTL/TTL logic is employed in both instruments. Logic 1 = +5 volts (+2.4 volts min.); logic 0 = 0 volt (+0.4 volt max.).

3-2. OVERALL DESCRIPTION, MODEL SR-202

As shown in figure 3-2, the Model SR-202 consists basically of a solid state control transformer which operates in a continuously tracking closed-loop feedback configuration. The control transformer compares input angle θ with digital angle ϕ supplied by the up-down counter, and generates an error voltage E which is a function of the sine of residue angle $\theta - \phi$. The error voltage is demodulated and integrated by the error processor, the output of which controls the up-down counter such that at null, angle θ = angle ϕ. Angle ϕ, a digital replica of the synchro or resolver input angle θ, is displayed on a visual readout and is simultaneously made available to the external system via the digital interface.

The Model SR-202 may be operated locally or remotely. In local operation, the front panel controls select synchro or resolver inputs, line-to-line levels, track or freeze operating modes, and high or low-bandwidth operation. A test of the LED display may also be initiated manually. In remote operation, control of command functions and signal inputs is transferred to the external system.

During track operation, the converter performs all normal tracking functions and the digital output follows the angular input within specified accuracy. In freeze operation, the digital output freezes at its last setting regardless of angular input. It should be noted that in the freeze mode only the digital portion of the loop is frozen. Therefore, if the converter is inhibited and the input signal changes significantly, the BITE signal will be energized when the delta angle (frozen angle - input angle) reaches the BITE level (approx. 2.5°). A wiring option at the rear connector will allow blanking of the display when this point is reached.

3-3. DETAILED DESCRIPTION, MODEL SR-202. (See figures 3-2, 4-1, and 4-2.)

Three-wire synchro data or 4-wire resolver data at 11.8, 26, or 90 volts rms line-to-line, representing input angle θ, is applied to input transformer T2. This precision

transformer provides high input impedance and effectively isolates the SR-202 electrically from the external system. The primary windings of T2 are configured by relay K1 to accept either 3-wire synchro data (K1 deenergized) or 4-wire resolver data (K1 energized). Relay operation is controlled by the synchro/resolver select logic applied to relay driver circuit Q1 from the SYN/RSLVR MODE switch (LOCAL-REMOTE switch in LOCAL) or from J1-1 (LOCAL-REMOTE switch in REMOTE). A logic high level selects resolver operation; a logic low initiates synchro operation. For synchro operation, T2 is connected in Scott-T form, converting the 3-wire input into 4-wire resolver signals. In resolver operation, input voltages are simply stepped down by T2. The transformer outputs, -S(-sin) and +C(+cos), are referenced to analog ground (voltage V), and are applied to module A4. Voltage V is +3.0 volts dc, referenced to power ground.

Level select and octant switching module A4 converts the -S and +C voltages into functions that define the octant of digital angle ϕ. To accommodate the different line-to-line voltages that may be applied to the instrument from the external synchro or resolver, level selection is effected by a level select circuit in module A4. The proper gain or attenuation is applied to the -S and +C voltages in response to the level select code applied to pins 41(L1) and 42(L2) of the PC board from the L-L VOLTAGE switches (local operation) or from J1-41 and J1-42, respectively (remote operation). The level select code is shown in table 3-1.

Table 3-1. Level Select Code

L-L Voltage	L1	L2
11.8v	Hi	Hi
26v	Lo	Hi
90v	Hi	Lo

The code converter, part of module A6, decodes the higher ordered BCD bits into quadrant and octant bits, and residue bits. For example, receipt of a logic 1 (high) level on the bit 200 input causes output bits 180 and 20' (representing 180° and 20°, respectively) to rise to logic 1 levels. The code converter input-output code is shown in table 3-2. The decoded 45°, 90°, and 180° bits, derived from the higher-ordered bits of digital angle ϕ, are fed to the octant decode logic, consisting of exclusive-OR gates U11 and U14 at the inputs of module A4. The resulting 3-bit octant select code, shown in table 3-3, causes the octant switching circuit to switch to the octant in which the applied angle falls. The sine and cosine voltages in module A4 then assume the waveforms shown in figure 3-1 at pins C and D. These two trigonometric functions, which define the octant of the digital angle, are applied to the three interpolator modules A1, A2, and A3, and to the error processor module A5.

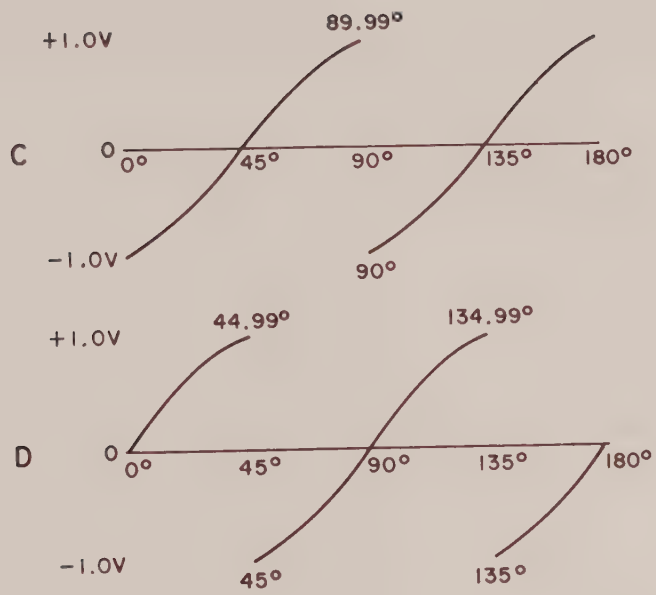


Figure 3-1. Interpolator Input Waveforms

The interpolator decode logic (gates U8-U11, U13, and U14) operates on the eight lower-ordered BCD bits .01° through .8° from the up-down counter and the decoded 1°, 2°, 4°, 5°, 10°, 20°, and 45° bits from the code converter. These bits determine where the digital angle falls within the designated octant. As shown in figure 4-1, the exclusive-OR gates at the digital inputs of the three interpolators are controlled by the 45° bit. As the digital angle passes through each octant, the digital outputs of the interpolator decode logic reverse the sense of the interpolators. This is equivalent to interchanging the signals at pins C and D, enabling continuous interpolation. The non-linear trigonometric interpolators use the lower ordered bits of the digital angle to generate an error voltage E which is proportional to the sine of the residue angle within the range of the designated octant. Thus, voltage E is proportional to

$$\sin(\theta - \phi)\sin(\omega t + \alpha)$$

where α is the phase shift through the external synchro or resolver.

The error signal is demodulated in error processor A5, with the phase of the demodulation derived from signals C and D rather than the reference voltage from the isolation transformer. Since the phase of signals C and D is a function of $\omega t + \alpha$, this feature effectively negates the effects of phase shift and quadrature error introduced by the external synchro or resolver. The reference voltage is used only to ensure that lock-on doesn't occur 180° out of phase with the angular input. Phase of the reference relative to signal may vary up to ±20° without affecting system accuracy. The 45° digital bit is applied to the error processor to change its sense in accordance with the octant of operation.

Table 3-2. Code Converter Truth Table

ANGLE (DEGREES)	INPUT CODE										OUTPUT CODE									
	1	2	4	8	10	20	40	80	100	200	1'	2'	4'	5''	5'	10'	20'	45	90	180
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
4	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
5	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
6	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
7	1	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
8	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
9	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
10	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
11	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
12	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
13	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
14	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
15	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
16	0	1	1	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0
17	1	1	1	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
18	0	0	0	1	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0
19	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0
20	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
30	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0
40	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0
45	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
50	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
60	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	1	0	0
70	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	1	1	0	0
80	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0
90	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0

Table 3-2. Code Converter Truth Table (cont'd)

ANGLE (DEGREES)	INPUT CODE										OUTPUT CODE									
	1	2	4	8	10	20	40	80	100	200	1'	2'	4'	5''	5'	10'	20'	45	90	180
100	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0
110	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0
120	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	1	0
130	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	1	1	0	1	0
135	1	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0
140	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	1	1	0
150	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	1	0	1	1	0
160	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	1	1	0
170	0	0	0	0	1	1	1	0	1	0	0	0	0	1	0	1	1	1	1	0
180	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
190	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1
200	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1
210	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1
220	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1	0	0	1
225	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1
230	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	1
240	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	1	0	1
250	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	1	1	0	1
260	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0	1	1	1	0	1
270	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1
280	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	1
290	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	1	1
300	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	1	1
310	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	1	1	0	1	1
315	1	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1
320	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	1	1	1
330	0	0	0	0	1	1	0	0	1	1	0	0	0	1	0	1	0	1	1	1
340	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	1	1	1	1
350	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	1	1	1	1	1

Table 3-3. Octant Select Code

Octant	Degrees	45°	90°	180°
1	0-44.99	0	0	0
2	45-89.99	1	0	0
3	90-134.99	1	1	0
4	135-179.99	0	1	0
5	180-224.99	0	1	1
6	225-269.99	1	1	1
7	270-314.99	1	0	1
8	315-359.99	0	0	1

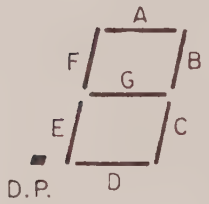
The demodulated signal undergoes one integration, resulting in a type II feedback loop that eliminates velocity tracking error. The error processor delivers two signals, U and T, to the up-down BCD counter. When digital angle $\emptyset$ must be increased to effect a null, the voltage at pin U rises and the error processor generates a toggle pulse when this voltage reaches approximately +5 volts (logic 1). The counter is triggered on the trailing edge of the toggle pulse, causing the count to increase by one LSB (.01°). Conversely, the voltage at pin U drops when the digital angle must be decreased, and the toggle pulse is generated when the voltage reaches zero volts (logic 0). The trailing edge of the toggle pulse then decreases the count by one LSB. After each counter change, pin U returns to +3.0 volts. If the synchro or resolver that drives the converter rotates at a constant rate, a sawtooth waveform appears at pin U. The 18 BCD bits representing the digital angle are fed back to the solid state control transformer to maintain its closed loop operation. The digital angle $\emptyset$ is also applied to the visual readout for real-time monitoring and is routed to the external system through buffer gates in the digital interface.

As shown in figure 4-1, the visual readout consists of five 7-segment LED displays, DS1 through DS5, each of which is driven by a decoder-driver IC chip. Depending on the 4-bit BCD input applied to pins 6, 2, 1, and 7, each decoder-driver draws current through one or more LED's, causing a digit to be displayed. LED segment assignments and the truth table for the decoder are shown in table 3-4. Since the hundreds digit never exceeds 3, pins 6 and 2 of U1 are grounded. Grounding pin 6 of DS4 through resistor R44 turns on the decimal point between the third and fourth digits. In addition, LED display DS5 is rotated 180° so that, with pin 6 of DS5 grounded through R45, the decimal point integral with the display appears in the degrees position. Pin connections to DS5 are changed accordingly to maintain the normal 0 to 9 readout.

Table 3-4. Display Truth Table

U1-U5 DECODER DRIVER CODE											DISPLAY
INPUT CODE				OUTPUT STATE							
				A	B	C	D	E	F	G	
6	2	1	7	13	12	11	10	9	15	14	
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	1	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

LED
SEGMENT ASSIGNMENTS



The lamp test feature may be initiated locally or remotely. In local operation (LOCAL-REMOTE switch in LOCAL), depressing the LAMP TEST pushbutton places a logic low level on pin 26 of the PC board. In remote operation (LOCAL-REMOTE switch in REMOTE), pin 26 of J1 must be programmed for a logic low level. In either case, current is drawn through all LED's in each display, producing a readout of 888.88°. This checks the operation of all segments in the LED's. The readout is configured so that the decimal point and degree sign LED's are driven on as long as power is applied to the instrument.

Freeze operation is initiated when the FREEZE pushbutton is depressed (LOCAL-REMOTE switch in LOCAL position) or when a logic low level is applied to J1-10 (LOCAL-REMOTE switch in REMOTE). This produces a logic low level at the INH pin of module A5, inhibiting the toggle pulse output and freezing the digital angle at the last count of the up-down counter.

Bandwidth selection is controlled by the BANDWIDTH switch (LOCAL-REMOTE switch in LOCAL position) or by the logic level applied to J1-8 (LOCAL-REMOTE switch in REMOTE). Selection of high bandwidth (logic 1 input) enables higher tracking speeds and acceleration constants for signal frequencies greater than or equal to 400 Hz.

The error processor module A5 provides two output controls via the digital interface: CB (converter busy) and BITE (built-in test equipment). A logic low pulse is generated at pin CB coincident with the leading edge of each toggle pulse. CB pulses are of longer

duration so that they overlap the trailing edges of the toggle pulses. The CB pulses are transmitted as flags to the external system to indicate that counter output data is changing. Stable data is made available to the external system during non-CB (logic high) intervals.

When the error processor detects an abnormally large residue angle caused by an excessively high synchro or resolver rotation rate or a malfunction, it generates a logic 1 on the BITE line, alerting the external system of this fault condition. In addition, if the user has jumpered pins 11 and 40 of J1 via the external connector, the numerical portion of the LED display is blanked out, leaving only the decimal point and degree sign. However, the BITE condition does not inhibit the 18-line digital readout through the digital interface.

NOTE

During freeze operation, the BITE line will also be energized if the input angle changes significantly (by approximately 2.5°) from the frozen digital angle. Thus, shifting to freeze operation may ultimately lead to display blanking if the unit is wired for BITE blanking.

Application of a logic 0 to the OUT EN (output enable) line disables the output buffer stages in the digital interface, inhibiting all output signals and producing a digital output of 000.00° at the output connector. However, the instrument continues to track and display the input angle.

The current-limited power supplies (figure 4-1) generate +15, -15, +5, and +4.3 volts regulated. Power transformer T1, driven by 115 volts or 230 volts at 47 to 440 Hz, is common to all supplies. (Internal switch S2 is normally set at the factory to the 115V position.) Full-wave rectifier diodes CR1 and CR3, and filter C1, provide the unregulated positive voltage for the +15-volt regulator circuit. Diodes CR2 and CR4, in conjunction with RC filter R55-C2, develop the negative voltage. The +15-volt regulator circuit consists of U22, R1, R2, and R5. Resistor R5 senses the drain on the +15-volt supply, limiting current during overcurrent intervals. Operational amplifier U23 is configured with identical valued resistors R3 and R4 connected to input terminal 2. Since U23 maintains this terminal at ground potential, the -15-volt output is slaved to the +15-volt regulated output. Emitter follower Q2, at the output of U23, increases the current available for the -15 volt load. This current is sensed by R48 which turns on Q1 when excessive current is drawn, removing drive from Q2 and effectively providing short circuit protection.

A full-wave bridge CRA7 and input filter C4, driven from a separate winding on transformer T1, develop an unregulated positive voltage for the +5 and +4.3-volt power supplies. The base voltage of pass transistor Q4 is maintained constant by zener diode CR6; the emitter of Q4 supplies the +5-volt output. Transistor Q6, driven by the ac voltage at T1-8, pulses Q5, thus pulsing the 4.3 volts that drives the decoder drivers and LED's in the visual readout. Overcurrent conditions in these supplies are sensed by R7 which turns on Q3 to remove the base drive from Q4, thus limiting the current drain during such intervals.

3-4. OVERALL DESCRIPTION, MODEL SR-102A

As shown in figure 3-2, the basic converter circuit of the Model SR-102A is identical to that of the SR-202. In the SR-102A, all control functions must be programmed remotely; all input and output signals pass through the rear-mounted connector. The front panel POWER switch is the only manual control. No synchro/resolver select relay is used; input connections to transformer T2 must be programmed for the desired synchro or resolver format.

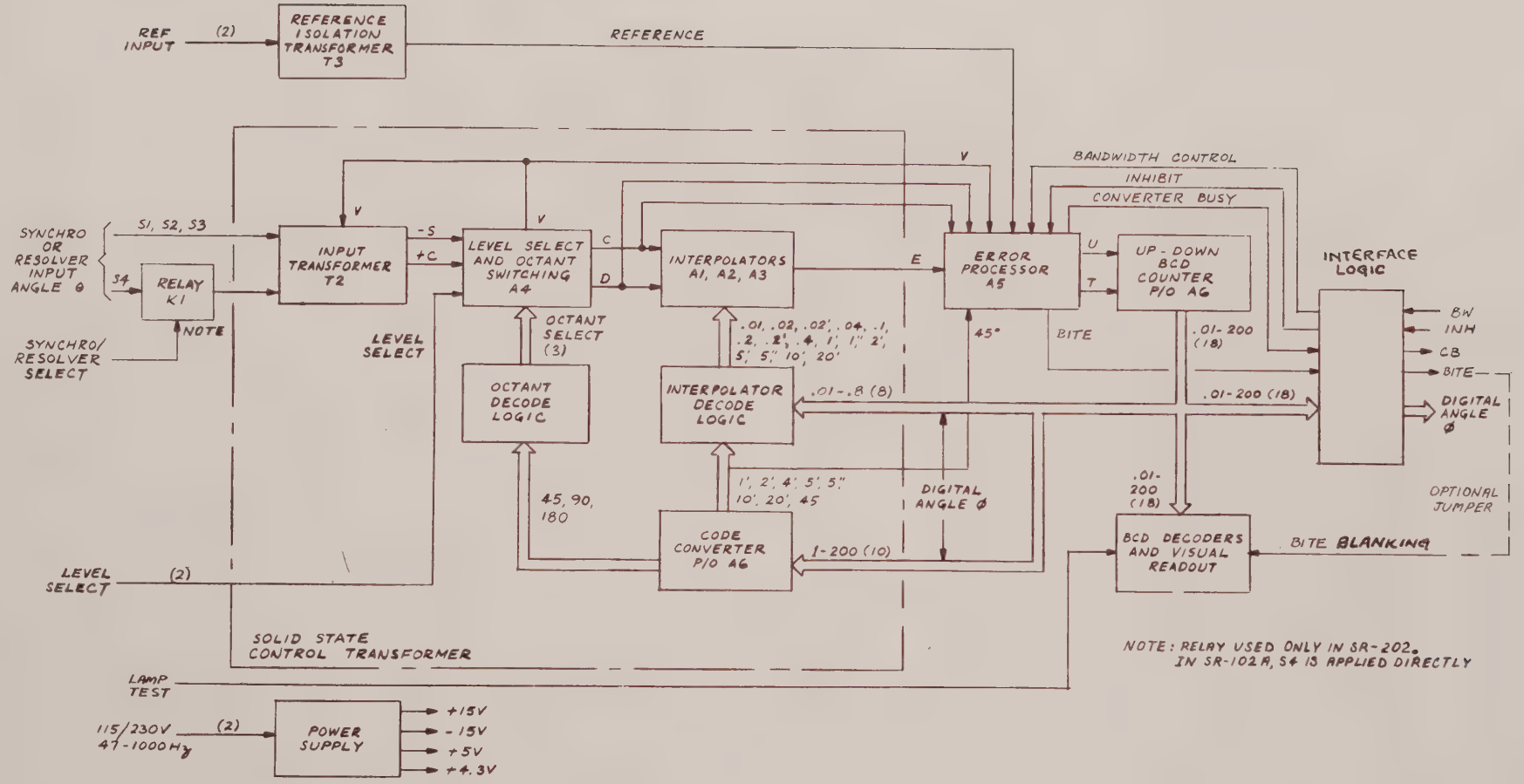


Figure 3-2. Models SR-102A and SR-202, Block Diagram

SECTION IV

MAINTENANCE

4-1. GENERAL

This section contains procedures and data that will help ensure continuity of service of the Models SR-102A and SR-202. Personnel involved in maintaining either unit should be familiar with its physical make-up and principles of operation before attempting to troubleshoot it.

4-2. PREVENTIVE MAINTENANCE

At 6-month intervals, clean the exterior of the instrument with a soft brush or cloth. No other preventive maintenance is required.

4-3. PERFORMANCE EVALUATION AND CALIBRATION TEST

Table 4-1 summarizes the procedure that should be used as a routine calibration test or an evaluation test on a new unit. A 400-Hz source (such as an oscillator or amplifier) that is capable of delivering an rms voltage variable from 8.34 to 78 volts is required. In each step of table 4-1, program the unit for synchro or resolver operation and for the line-to-line voltage indicated, short the designated input leads, and apply the signal input to the input connections shown. (Set up the SR-202 for local operation and use the front panel binding posts for input connections. For the SR-102A, See table 2-1 for input pin connections.) The instrument should display the angle shown within its rated accuracy. The reference voltage must be derived from the same source as the signal, but connections to the reference inputs should not be switched when the signal input connections are reversed.

4-4. CORRECTIVE MAINTENANCE

Corrective maintenance consists of procedures designed to correct problems that have caused the instrument to malfunction. Corrective maintenance procedures include troubleshooting, repair, and replacement. These instruments do not require adjustment.

4-5. TEST EQUIPMENT REQUIRED. A good general purpose dual-channel oscilloscope, VTVM, 400-Hertz oscillator and a synchro equipped with a calibrated dial are required for corrective maintenance.

4-6. TROUBLESHOOTING. Table 4-2 is included to facilitate troubleshooting. The table does not include all possible faults that may occur but it does provide a systematic logical approach to trouble localization and indicates areas that should be checked. Using this data as a guide, in conjunction with the overall schematic diagrams, it should be possible to localize equipment malfunctions to the level of a replaceable part.

NOTE

It is assumed in table 4-2 that the display blanking feature of these angle indicators is being used, i.e., pins 11 and 40 on J1 have been jumpered.

When troubleshooting, one channel of the oscilloscope should be synchronized to the reference voltage. One cycle of the reference should be set up as a time base against which the magnitude and phase of signals developed in the instrument can be compared.

4-7. MODULE REPLACEMENT. To simplify troubleshooting and module replacement, all connections to the modules are made only on the dip side, using non-plated through connections. To isolate a pin from its pad on the PC board so that it may be measured independently of external circuits, unsolder the pin from the pad, then sleeve the pin to insulate it from the pad. To remove a module, unsolder all of its pins, then lift it off the PC board. All components are accessible with the top and bottom covers of the instrument removed.

Table 4-1. Test Summary

STEP	SIGNAL TYPE/ LEVEL CONTROL	SHORTED INPUT LEADS	INPUT CONNECTIONS HI	INPUT CONNECTIONS LO	SIGNAL INPUT VOLTAGE	DISPLAY
1	Synchro/11.8V	S1, S3	S1/S3	S2	10.2V	180.00°
2			S2	S1/S3		000.00°
3		S2, S3	S1	S2/S3		240.00°
4			S2/S3	S1		60.00°
5		S1, S2	S3	S1/S2		120.00°
6			S1/S2	S3		300.00°
7	Synchro/26V	S1, S3	S1/S3	S2	22.5V	180.00°
8			S2	S1/S3		000.00°
9		S2, S3	S1	S2/S3		240.00°
10			S2/S3	S1		60.00°
11		S1, S2	S3	S1/S2		120.00°
12			S1/S2	S3		300.00°
13	Synchro/90V	S1, S3	S1/S3	S2	78V	180.00°
14			S2	S1/S3		000.00°
15		S2, S3	S1	S2/S3		240.00°
16			S2/S3	S1		60.00°
17		S1, S2	S3	S1/S2		120.00°
18			S1/S2	S3		300.00°
19	Resolver/11.8V	S2, S3 and S1, S4	S2/S3	S1/S4	8.34V	45.00°
20			S1/S4	S2/S3		225.00°
21		S1, S2 and S3, S4	S1/S2	S3/S4		315.00°
22			S3/S4	S1/S2		135.00°
23	Resolver/26V	S2, S3 and S1, S4	S2/S3	S1/S4	18.4V	45.00°
24			S1/S4	S2/S3		225.00°
25		S1, S2 and S3, S4	S1/S2	S3/S4		315.00°
26			S3/S4	S1/S2		135.00°
27	Resolver/90V	S2, S3 and S1, S4	S2/S3	S1/S4	63.6V	45.00°
28			S1/S4	S2/S3		225.00°
29		S1, S2 and S3, S4	S1/S2	S3/S4		315.00°
30			S3/S4	S1/S2		135.00°

Table 4-2. SR-102A and SR-202 Troubleshooting Chart

Step	Test Procedure	Performance Standard	Trouble Symptom	Corrective Action
1	On SR-102A, set up unit for tracking operation at convenient synchro input and reference levels. On SR-202, connect synchro and reference inputs to binding posts and select mode and voltage levels with front panel controls. Apply power and maintain input angle constant.	Normal readout appears on display.	Visual display is completely blanked out.	Check fuse on rear panel and ascertain that ac power is present. If so, check +4.3-volt power supply.
			Digits are blanked out but decimal point and degree dots are lit.	Check that all synchro and reference inputs are present. For a 115-volt reference input, pin R of A5 should be 6 volts. For a 26-volt reference, it should be 1.35 volts. (In SR-202, if synchro inputs are abnormal, check relay K1 circuit.) If all inputs are normal, proceed to step 2.
			Display flickers at specific sectors, angles, or bit positions.	On SR-102A, ground LT line at J1-26. On SR-202A, depress LAMP TEST pushbutton. If test display (888.88°) is not normal, trouble is in LED's or associated decoder-drivers. If test display is normal, proceed to step 9.
			Readout counts up only or down only.	Proceed to step 10.
			Readout is stable but erroneous or illegal.	Check decade and decoder driver associated with faulty readout in visual display. Check for open wire between A6 and pertinent decoder-driver chip.

Table 4-2. SR-102A and SR-202 Troubleshooting Chart (cont'd)

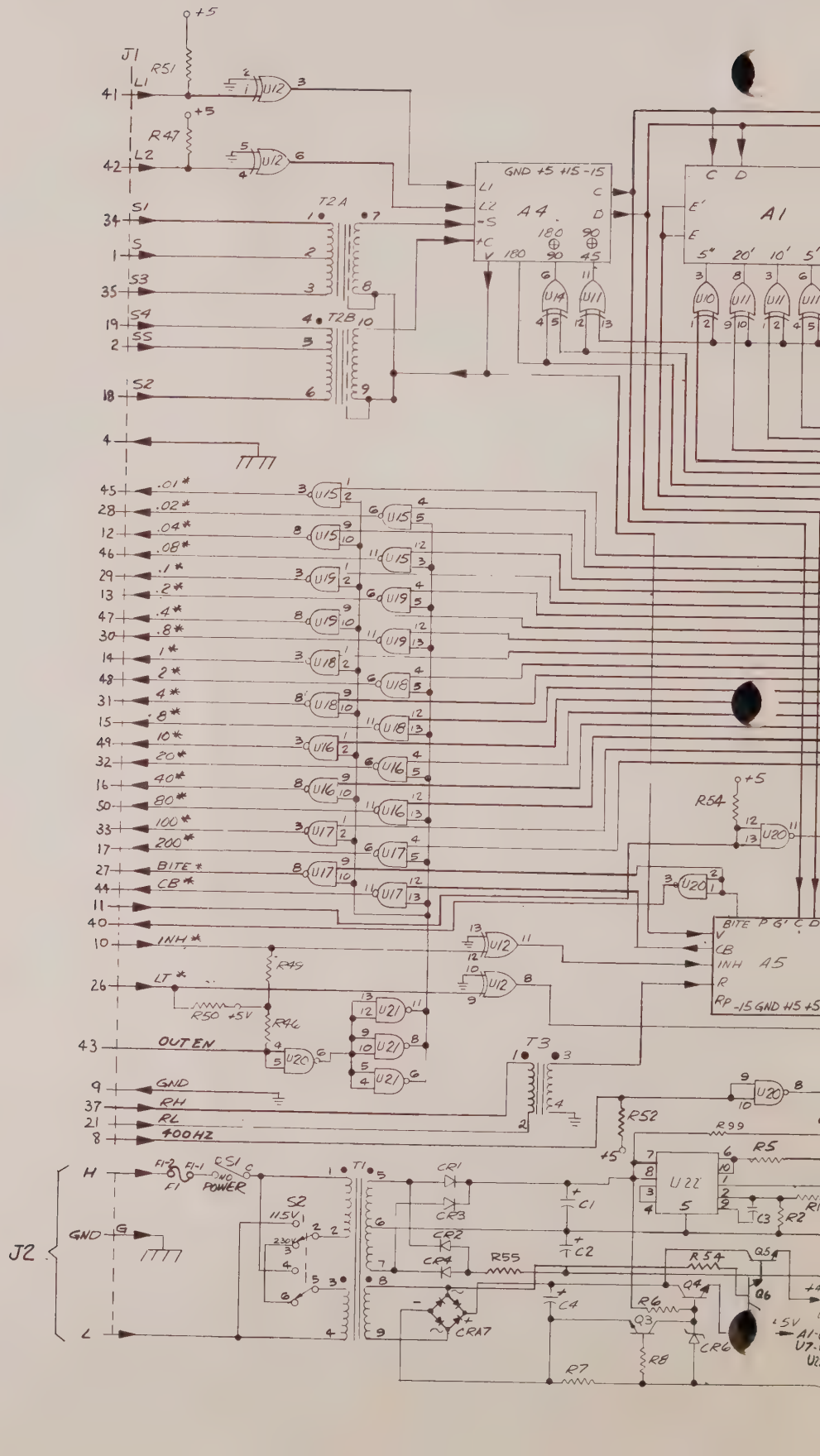
Step	Test Procedure	Performance Standard	Trouble Symptom	Corrective Action
2	Visually inspect interior of instrument for broken wires, etc. Check that all power supply outputs are normal. (Measure at marked module terminals.)	Normal supply voltages are as follows: +15v ± 5% -15v ± 5% + 5v ± 10%	One or more supply voltages is abnormal.	If all voltages are normal, proceed to step 3. If any voltage is abnormal, unload that power supply output by unsoldering lead and checking supply under no load. If no-load output is abnormal, check power supply for faulty component. If no-load output is normal, unload one module at a time until defective module is located.
3	Measure dc voltage from A4-V to ground.	A stable reading of +3.0 ± 0.3 volts.	V voltage is abnormal.	If +15-volt input to A4 is normal, replace A4. If V voltage is normal, proceed to step 4.
4	Vary angular input, monitoring T2 output with respect to V.	-Sine and +cosine voltages at a dc level of +3.0 volts (V voltage)	Either or both voltages abnormal.	If -S and +C voltages are normal, proceed to step 6. If -S/+C voltages are abnormal, check octant select inputs to A4. (See table 3-3.) If octant select inputs are normal, proceed to step 5.
5	On T2, unsolder lead that exhibits abnormal output. Monitor unloaded voltage at T2.	Same as step 4.	Voltage is normal. Voltage is abnormal.	Unsolder the leads from pins C and D on A4 and reconnect T2 inputs to A4. If any T2 input is still abnormal, replace A4. Replace T2.

Table 4-2. SR-102A and SR-202 Troubleshooting Chart (cont'd)

Step	Test Procedure	Performance Standard	Trouble Symptom	Corrective Action
6	Monitor the C and D outputs on A4.	0-1.0 volt rms voltages at dc level of V voltage. (See waveforms of figure 3-2.)	Either voltage is clamped to ground or to +5 volts.	Unsolder C or D lead from A4 and recheck unloaded voltage at A4. If still abnormal, replace A4. If line appears to be normal, connect 750 ohm resistor between +15-volt output and suspected C or D line. If output again becomes abnormal, replace A4. If normal, proceed to step 7.
7	Connect jumper between BITE and GND pins on A5.	Digital readout is unblanked.	Digits in display remain blanked. Display becomes unblanked.	Check visual display. Proceed to step 8.
8	Remove ground connection from BITE pin on A5. Short synchro input lines together.	Same as step 7.	Digits in display become blanked. Digits in display become unblanked but readout keeps changing.	Replace A5. On SR-102A ground inhibit line at J1-10. On SR-202, depress FREEZE pushbutton. If display continues to change, replace A5.
9	On SR-102A, remove ground from J1-10. On SR-202, depress TRACK pushbutton. Rotate synchro input angle through all octants.	Normal readout occurs through each octant.	Angular readout corresponding to a particular octant is abnormal.	Check that octant select inputs to A4 are normal. (See table 3-3.) If 45°, 90°, and 180° bits from A6 are normal, replace octant decode logic gates U11 and/or U4. If any bit is not generated, replace A6.

Table 4-2. SR-102A and SR-202 Troubleshooting Chart (cont'd)

Step	Test Procedure	Performance Standard	Trouble Symptom	Corrective Action
9 (cont'd)			Readout corresponding to particular angle or bit position is abnormal.	Check that each interpolator is receiving the proper bit inputs from interpolator decode logic (exclusive-OR gates U8-U11, U13 and U14). If normal, replace associated interpolator. If abnormal, replace defective gate or module A6, as required.
10	If readout is in one direction only, shift angular input to force counter in opposite direction. Monitor waveforms at pins U and T of A5.	Ramp is negative going when the readout is to be driven down and positive-going when the readout is to be driven up. Triggers occur at +5-volt and 0-volt levels of ramp.	Waveforms are normal. Waveforms are abnormal.	Replace A6. Replace A5.
11	Set up SR-202 for resolver input tracking operation.	Digital output follows resolver input.	Digital output is abnormal.	Check relay K1 circuit.


J1
J2
A4
A1
A5
T1
T2A
T2B
T3
GND +5 +15 -15
OUTEN
GND
RH
RL
400HZ
INH *
LT *
BITE *
CB *
POWER
115V
230V
.01 *
.02 *
.04 *
.08 *
.1 *
.2 *
.4 *
.8 *
1 *
2 *
4 *
8 *
10 *
20 *
40 *
80 *
100 *
200 *

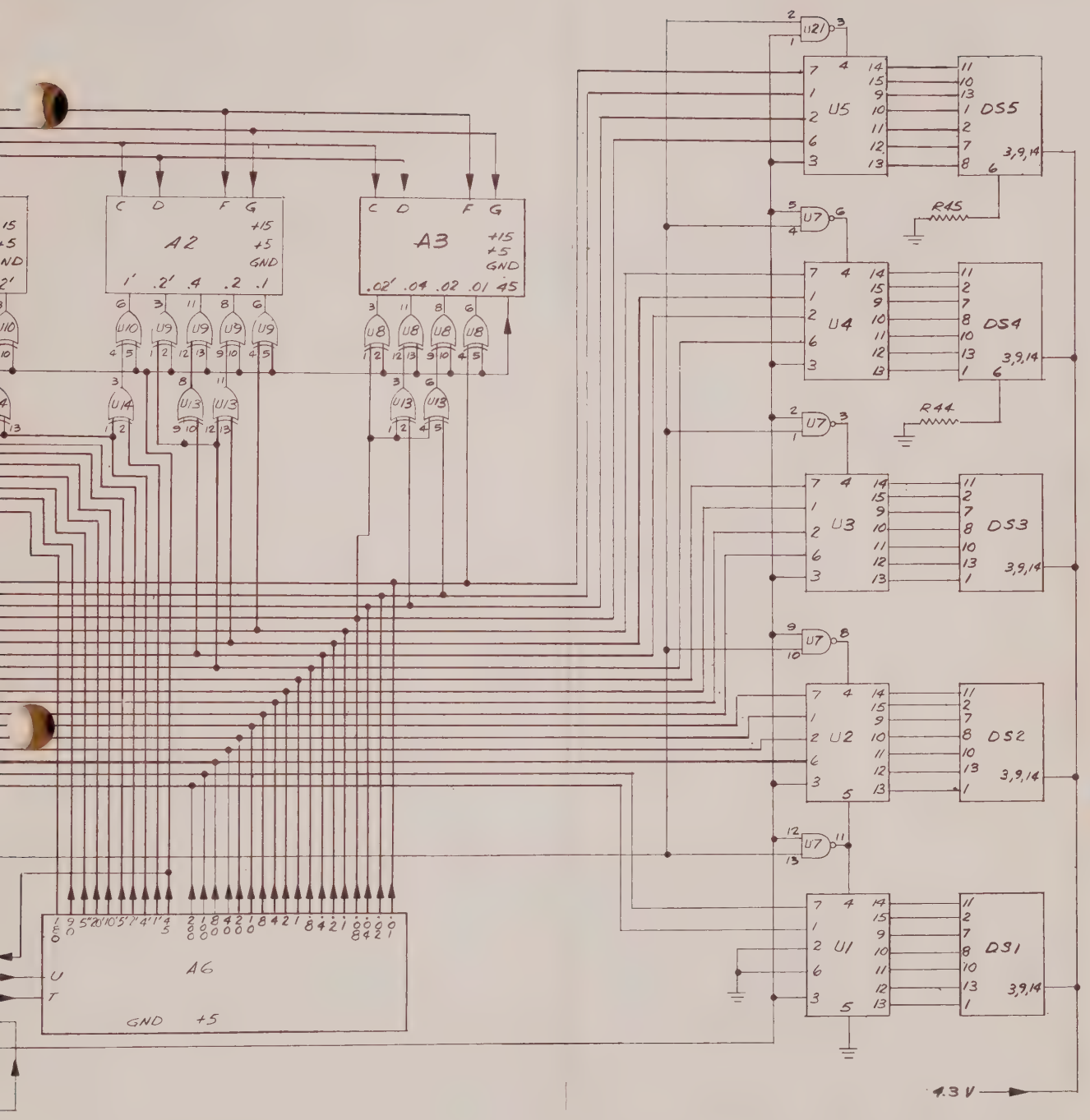


Figure 4-1. Models SR-102A and HSR-102A, Schematic Diagram
Models SR-202 and HSR-202, Schematic Diagram (Sheet 1 of 2)

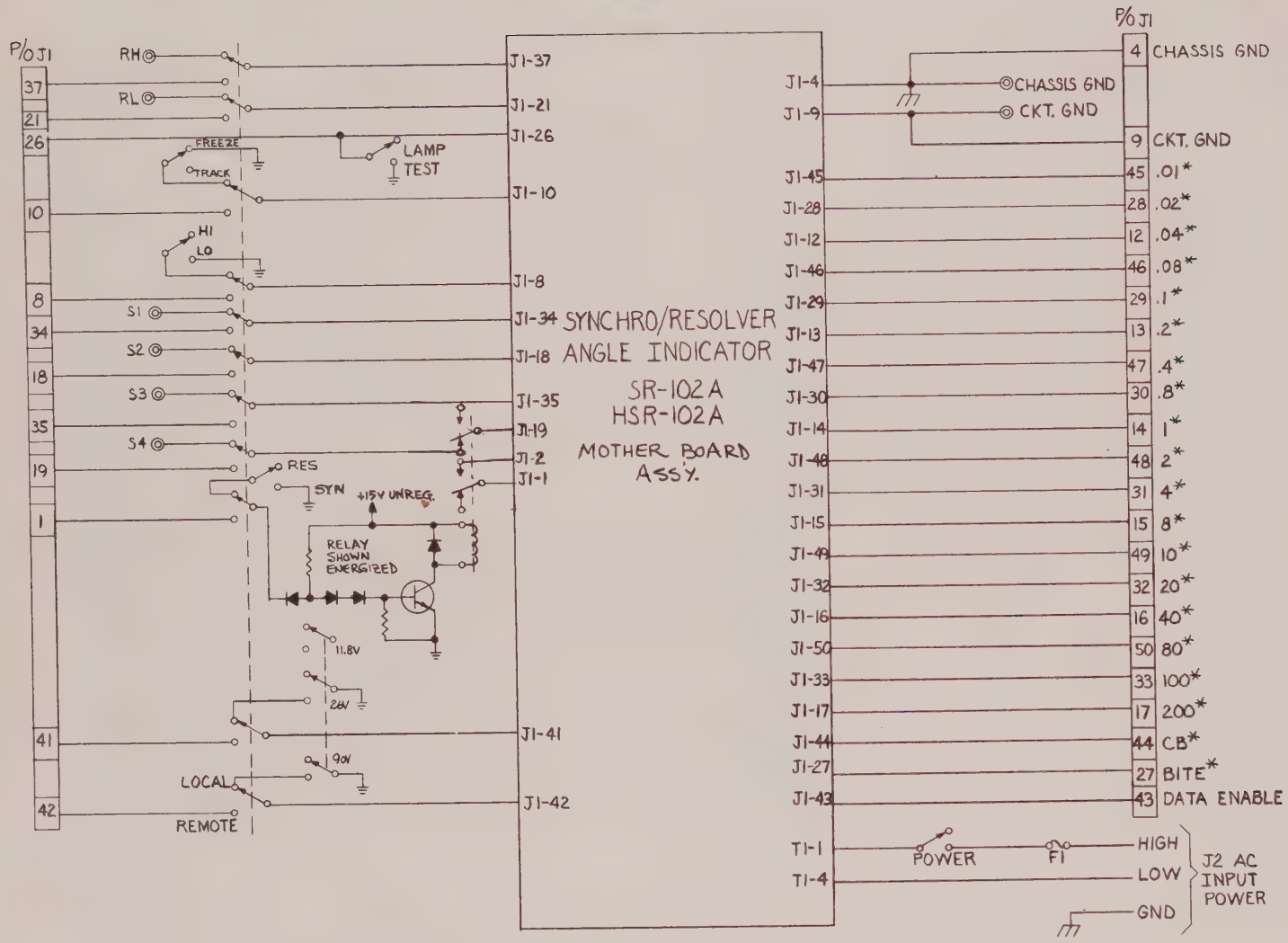


Figure 4-2. Models SR-202 and HSR-202, Schematic Diagram (Sheet 2 of 2)

SECTION V

PARTS LIST

5-1. INTRODUCTION

This section contains the parts list (table 5-1) and "Parts Locator" drawings.

5-2. REFERENCE DESIGNATIONS

The unit numbering method of assigning reference designations to components of the Synchro/Resolver Angle Indicator is based on the physical and functional locations of the components. All electrical components are mounted on one of the indicator subassemblies. The first digit in each reference designation indicates on which subassembly that component is mounted. The subassemblies are identified as follows:

Subassembly 1 - Main Printed Circuit Board

Subassembly 2 - Front Panel

Subassembly 3 - Rear Panel

Subassembly 4 - Chassis Subassembly (Model SR-202 only)

The remaining digits or letters of the reference designation identify the actual component class or type (i.e., PCB-printed circuit board, R-resistor, T-transformer, A-module, U-integrated circuit, etc.) and the item number within that class or type component. Therefore, the designation 1A1 identifies the first module located on the Main Printed Circuit Board. The designation 1PCB identifies the Printed Wiring Board which is used to make up the Main Printed Circuit Board.

5-3. REFERENCE DRAWINGS

Figure 5-1 is included in this section for Subassembly 1, Main Printed Circuit Board, of either model. Figure 5-2 locates the parts on Subassembly 4 of the Model SR-202. For physical location of parts on other subassemblies, refer to figures 1-1 through 1-3 in Section I.

Table 5-1. Parts List

REFERENCE SYMBOL	PART NO.	DESCRIPTION	MAN.	QTY	FIGURE
1PCB	12259	Printed Circuit Board, Main	DDC	1	1-2
1A1	SR010 HSR010	Encapsulated Module, Interpolator	DDC	1	1-2
1A2	SR020 HSR020	Encapsulated Module, Interpolator	DDC	1	1-2
1A3	SR030 HSR030	Encapsulated Module, Interpolator	DDC	1	1-2
1A4	SR040 HSR040	Encapsulated Module, Level Select and Octant Switching	DDC	1	1-2
1A5	SR050 HSR050	Encapsulated Module, Error Processor	DDC	1	1-2
1A6	SR060	Encapsulated Module, Up-Down BCD Counter	DDC	1	1-2
1C1, 1C2	MTV100E35	Capacitor, electrolytic, 100 uf	Mallory	2	5-1
1C3	VK23BW-101K	Capacitor, ceramic, 100 pf, 10%	Vitramon	1	5-1
1C4	39D408G015JL4	Capacitor, electrolytic, 4000 uf, 15 v	Sprague	1	5-1
1CR1-1CR4	1N4001	Diode, Silicon	Motorola	4	5-1
1CR5	1N4154	Diode, Silicon	GE	1	5-1

Table 5-1. Parts List (cont'd)

REFERENCE SYMBOL	PART NO.	DESCRIPTION	MAN.	QTY	FIGURE
1CR6	1N752A	Diode, Zener, 5.6v, 5%	TI	1	5-1
1CRA7	VH148	Diode Bridge Assy	Varo	1	5-1
1DS1-1DS5	MAN 1A	Light Emitting Diode Assy	Monsanto	5	5-1
1Q1, 1Q3	2N5812	Transistor	GE	2	5-1
1Q2	2N4037	Transistor	Any	1	5-1
1Q6	2N2222A	Transistor	Any	1	5-1
1R1	Mil Type RN55D	Resistor, Precision, 7.87K, 1%, 1/8W	Any	1	5-1
1R2	Mil Type RN55D	Resistor, Precision, 7.15K, 1%, 1/8W	Any	1	5-1
1R3, 1R4	Mil Type RN55D	Resistor, Precision, 10K, 1%, 1/8W	Any	2	5-1
1R5	RCR20	Resistor, Carbon, 1.8 ohm, 5%, 1/2W	Allen Bradley	1	5-1
1R6	995-1A	Resistor, Wirewound, 1K, 5%, 1/2W	Omite	1	5-1
1R7	BWH-2-.27	Resistor, Wirewound, 0.27 ohm, 10%, 2W	IRC	1	5-1
1R8	RCR07	Resistor, Carbon, 10 ohm, 10%, 1/4W	Allen Bradley	1	5-1

Table 5-1. Parts List (cont'd)

REFERENCE SYMBOL	PART NO.	DESCRIPTION	MAN.	QTY	FIGURE
1R44, 1R45	RCR07	Resistor, Carbon, 560 ohm, 10% 1/4W	Allen Bradley	2	5-1
1R46, 1R47, 1R49 - 1R53	RCR07	Resistor, Carbon, 4.7K, 10%, 1/4W	Allen Bradley	7	5-1
1R48	RCR07	Resistor, Carbon, 5.6 ohm, 10%, 1/4W	Allen Bradley	1	5-1
1R54	RCR07	Resistor, Carbon, 4.3K, 10%, 1/4W		1	5-1
1R55	RCR32	Resistor, 56 ohm, 5%, 1W	Allen Bradley	1	5-1
1S2	46256LFR	Switch, Slide	Switchcraft	1	1-3
1T1	11823C	Transformer, Power	DDC	1	5-1
1T2	5669	Transformer, Precision Signal	DDC	1	5-1
1T3	5670	Transformer, Reference	DDC	1	5-1
1U1-1U5	5110	Integrated Circuit, BCD to 7-Segment Decoder	Precision Dynamics	5	5-1
1U6		Not used			
1U7, 1U21	SW946-2P	Integrated Circuit, Quad 2-Input NAND Gate	SW	2	5-1
1U8-1U14	SW1812-2P	Integrated Circuit, Quad 2-Input Exclusive-OR Gate	SW	7	5-1
1U15-1U19	SW1806-2P	Integrated Circuit, Quad 2-Input AND Gate	SW	5	5-1

Table 5-1. Parts List (cont'd)

REFERENCE SYMBOL	PART NO.	DESCRIPTION	MAN.	QTY	FIGURE
1U20	SN7400	Integrated Circuit, Quad 2-Input NAND Gate	Stewart Warner	1	5-1
1U22	~~V5R7723393X~~ LM 723CH	Integrated Circuit, Voltage Regulator	Fairchild	1	5-1
1U23	741C	Integrated Circuit, Operational Amplifier	Any	1	5-1
2S1-2S3*, 2S6*	2XD15DSBBL2UGR	Switch, Pushbutton	IEE	4	1-1
2S4*	1XD15DSBBL2UOA	Switch, Pushbutton	IEE	1	1-1
2S5*	3XD15DSBBL2UGR	Switch, Pushbutton	IEE	1	1-1
2S7*	46-05-07-502-0303	Switch, Pushbutton	Grayhill	1	1-1
2S7	46256LFR	Switch, Pushbutton	Switchcraft	1	1-1
*	111-0110-001	Binding Post	E.F. Johnson	6	1-1
3F1	GMW-1	Fuse, Miniature, 1 Amp	Buss	1	1-3
3J1	17-10500-1	Receptacle, 50-Pin	Amphenol	1	1-3
3J2	AC3G	Receptacle, AC Line	Switchcraft	1	1-3
3J3*	EAC301	Receptacle, AC Line	Switchcraft	1	1-3
3Q4, 3Q5	2N3772	Transistor, Silicon Power NPN	Motorola	2	1-3
3R99	RH-5	Resistor, Wirewound, 140 ohms, 1%, 5W	Dale	1	1-3

Table 5-1. Parts List (cont'd)

REFERENCE SYMBOL	PART NO.	DESCRIPTION	MAN.	QTY	FIGURE
3XF1	HWA-AF	Fuseholder, Miniature	Buss	1	1-3
4PCB*	14956A	Printed Circuit Board, Chassis Subassembly	DDC	1	5-2
4CR1-4CR4*	1N4148	Diode	TI	4	5-2
4K1*	3SBC-51-34K1	Relay	G. E.	1	5-2
4R1, 4R2*	RCR07	Resistor, Carbon, 2K, 10%, 1/4W	Allen Bradley	2	5-2
4Q1*	2N2222A	Transistor		1	5-2
4XK1*	133176-01	Socket, Relay	Methode Electronics	1	5-2

*Asterisked items used on SR-202 only.

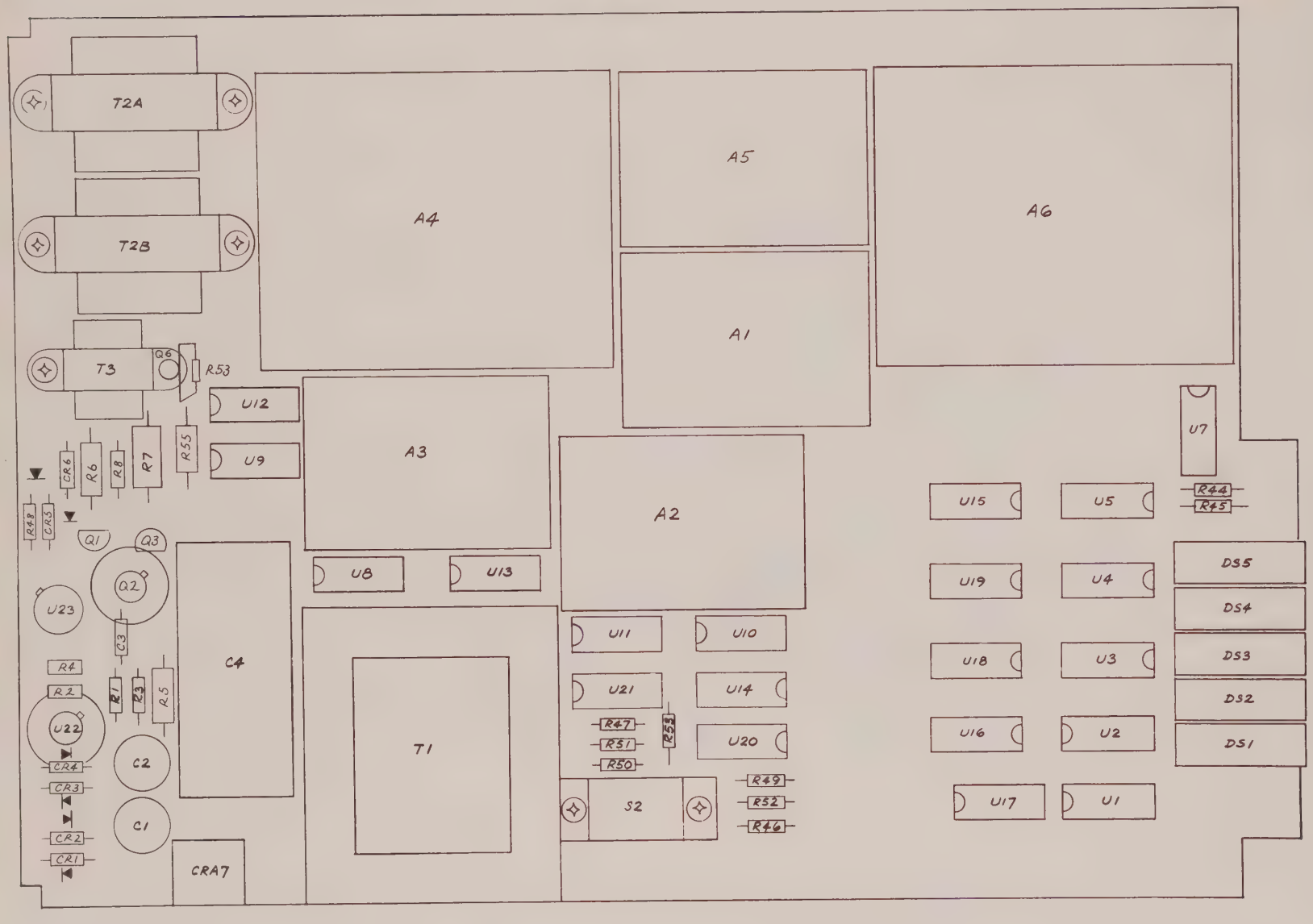


Figure 5-1. Main Printed Circuit Board, Parts Locator Drawing

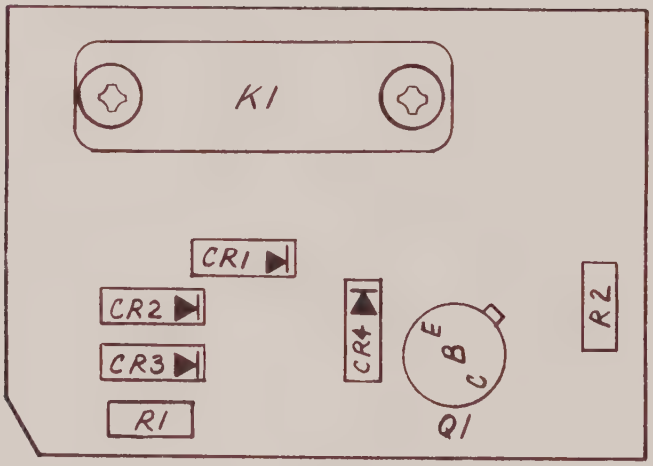


Figure 5-2. Chassis Subassembly, Parts Locator Drawing

Addendum Sheet

(SR-102A, HSR-102A, SR-202, HSR-202)

Some earlier models of the above units do not have display muxing circuitry incorporated. This circuitry is comprised of components R54 and Q6.

Table 4-1. Test Summary

Signal Type	Shorted Input Leads	Input Connections Hi	Input Connections Lo	Display
Synchro	S1, S3	S1/S3	S2	180.00° *
		S2	S1/S3	000.00° *
	S2, S3	S1	S2/S3	240.00° *
		S2/S3	S1	60.00° *
	S1, S2	S3	S1/S2	120.00°
		S1/S2	S3	300.00°
Resolver	S2, S3, and S1, S4	S2/S3	S1/S4	45.00°
		S1/S4	S2/S3	225.00°
	S1, S2, and S3, S4	S1/S2	S3/S4	315.00° *
		S3/S4	S1/S2	135.00° *

Table 4-2. Troubleshooting Chart

Trouble	Corrective Action
A. No display in either local or remote mode or abnormal display with instrument inhibited	Check the following: 1. Fuse F1 2. AC power 3. Settings of 115V/230V switches 4. Power supplies (see troubles B and C) 5. Clock U15, counter U23 and multiplexer switches U7 through U11 on converter board. 6. Driver U12, decoder U13, and resistor network R1 in converter board display circuits. 7. LED displays DS1-DS6 (or DS7 in HSR-203)
B. Abnormal power supply voltages on converter board	Check the following: 1. AC voltage across primary winding of T2 2. DC voltage across C1 and C2. 3. Outputs of U5 and U6 with U1 and U2 removed.

*Revised 12/82

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